

# **Motor Cortex&Cortical Control of Motor Function**

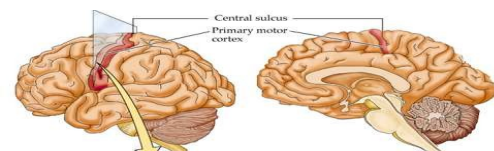
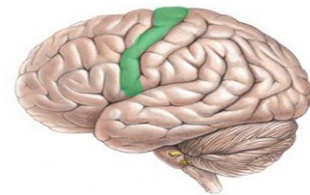
**Dr. DOAA ABOU-BAKR**

**Lecturer of Physiology**

**By the end of this lecture the student will be able to:**

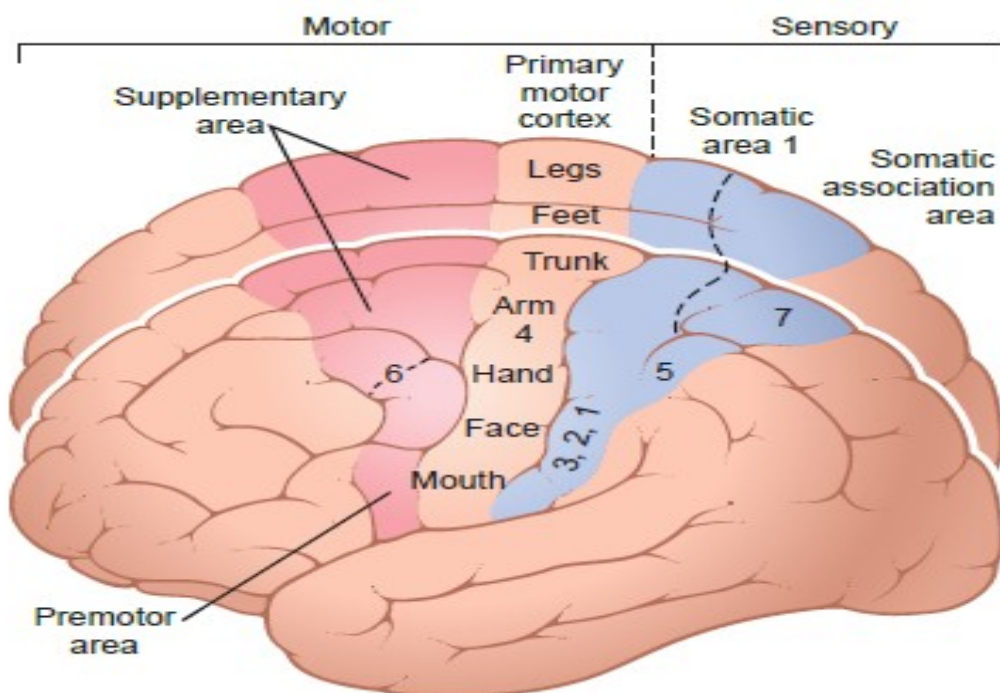
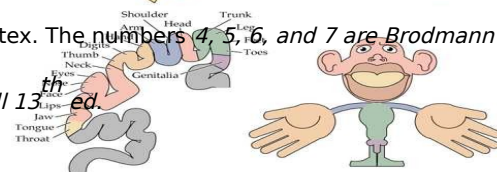
- ✓ List the cortical motor areas (primary, premotor, supplementary), their characteristics, functions & the effects of their lesions.
- ✓ Explain the importance of the related cortical structures located within the motor area 6 & their specific functions.
- ✓ Describe Prefrontal association area and list its functions.
- ✓ Describe the cortical control over the motor function.
- ✓ Describe cortical plasticity.

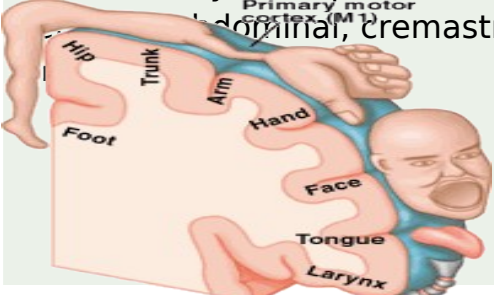
# Cortical motor areas



Motor and somatosensory functional areas of the cerebral cortex. The numbers 4, 5, 6, and 7 are Brodmann's cortical areas.

Guyton and Hall 13<sup>th</sup> ed.



Functions	Effects of Lesion
1- Initiation of fine discrete movements of the opposite side of the body e.g. fingers.	1- Loss of fine movements of opposite side of body in the form of monoplegia (localized).
2- Shares in initiation of gross movements of the opposite side.	2- Only weakness or paresis.
3- Facilitatory to the stretch reflex.	3- Hypotonia and Hyporeflexia.
4- Necessary for superficial abdominal, cremasteric	4- Loss of abdominal and cremasteric reflex.
	5- Partial Babiniski's sign: dorsiflexion of the big toe on scratching lateral aspect of the foot.

The motor homunculus in primary motor cortex. <https://brainconnection.brainhq.com/2013/03/05/the-anatomy-of-movement/>

## Motor area 6 (Premotor area)

**Site:** In front of motor area 4 on lateral aspect of frontal lobe (part of premotor cortex).

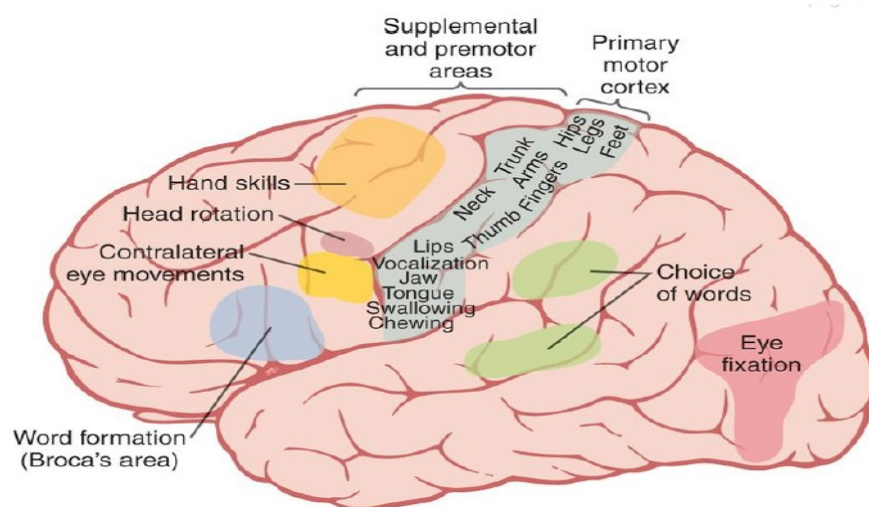
**Topographical representation:** is inverted and crossed.

Functions	Effects of Lesion
1- Controls gross movements of the	1- Paresis i.e weakness of voluntary movements But not

opposite side of body (big joints and limbs).	paralysis.
2- Contains memory for fine skilled movements.	2- Motor apraxia (inability to do skilled movement inspite of absence of paralysis).
3- Together with basal ganglia regulates automatic subconscious associated movements.	3- Loss of automatic associated movements(e.g. swinging of arms).
4- Inhibition of spinal reflexes (e.g. Inhibitory to stretch reflex & grasp reflex).	4- Increased muscle tone Spasticity (hypertonia) & Hyperreflexia & Appearance of grasp reflex.
5- Produces planter flexion of the lateral 4 toes (planter reflex).	5- Partial Babiniski's sign: Fanning of outer four toes.

## **Specialized areas in the premotor cortex**

4 important motor areas				
Name	Motor speech area (Broca's area) words formation (area 44)	Eye movement area ( frontal eye field area 8)	Head rotation area	Hand skills area
Site	lying immediately anterior to the primary motor cortex and immediately above the sylvian fissure.	In the premotor area immediately above Broca's area.	In the premotor area immediately above area 8.	In the premotor area ant. to the 1ry motor cortex for the hands and fingers.
Function	It stores the complex sequence of orders for vocalization.	Gives origin to corticonuclear tract of both sides; responsible for voluntary conjugate deviation of both eyes to opposite side.	It directs the head toward different objects.	It controls complex skilled movements e.g. sharpening of pencil or drawing figures.
Effect of damage	Does not prevent a person from vocalizing but makes it impossible for the person to speak whole words or an occasional simple word such as "no" or "yes."	Transient inability to produce conjugate eye movement, The tectospinal tract from superior colliculus compensates and the reflex eye movements return.	Inability to rotate the head toward different objects.	Agraphia and motor apraxia.



Representation of the different muscles of the body in the motor cortex and location of other cortical areas responsible for specific types of motor movements. Guyton and Hall 13rd ed.

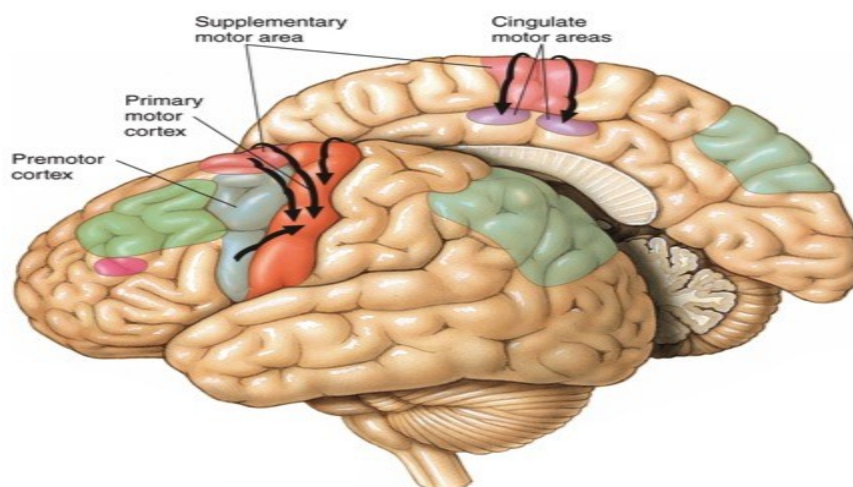
## **Supplementary motor area = medial area 6**

**Site:** Medial surface of premotor cortex (superior to area 6).

### **Functions:**

1- It supplements (helps) area 6 in the control of voluntary movements of the proximal parts of the body (gross movements) as a background for fine hand or feet movements.

2- It role



plays a  
in

planning of movements before they start specially complex and bilateral movements.

<https://brainconnection.brainhq.com/2013/03/05/the-anatomy-of-movement>

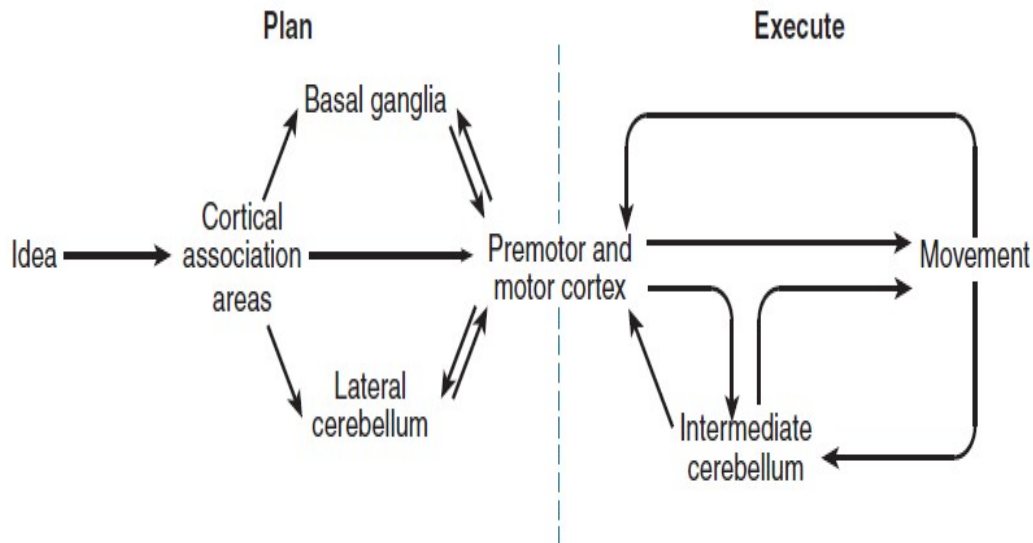
## **The prefrontal association area: Anterior association area**

**Site:** It lies in frontal lobe anterior to premotor area.

## Function:

1. Elaboration of **thoughts** and **ideas**.

2.



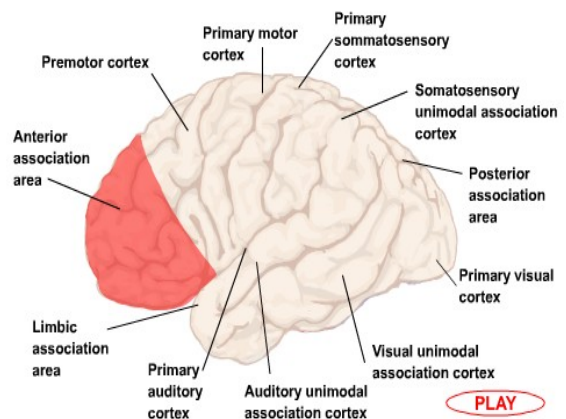
Because of its close association with the **motor cortex** it shares in planning complex patterns and sequences of motor movements.

3. As it contains **Broca's Area** (motor speech center) it plans and stores programs of motor patterns for expressing individual words.

4. Due to its connection to **hippocampus** it is involved in recent memory.

5. Due to its connection with the **limbic system** it shares in the control of emotional behavior.

## Cortical control over the motor function (MOTOR HIERARCHY):



**Control of voluntary movement:** Commands for voluntary movement originate in cortical association areas. The cortex, basal ganglia, and cerebellum work cooperatively to plan movements. Movement executed by the cortex is relayed via the corticospinal tracts and corticobulbar tracts to motor neurons. The cerebellum provides feedback to adjust and smooth movement. Ganong 24<sup>th</sup> ed.

The control of movement by the central nervous system is a ***complicated process*** that **involves multiple regions of the brain:**

1. Generation of **idea** occurs in the **prefrontal cortex**.
2. **Awareness** of the surrounding environment and position in space. This information is generated through **somatosensory, visual and auditory sensory** inputs to the posterior parietal cortex.
3. **Motivation** and past memories regulating the behavior takes place either rewarding or stopping the desire in the **limbic system**.
4. **Plan or program** performed in the **basal ganglia, cerebellum, premotor cortex (PMC)** and **supplementary motor areas (SMA)**.
5. **Execution** of motor orders through the cortex is relayed via the corticospinal tracts and corticobulbar tracts to motor neurons.

## **Cortical Plasticity**

The motor cortex shows the same kind of plasticity as already described for the sensory cortex.

***For example:***

-The finger areas of the contralateral motor cortex enlarge as a pattern of rapid finger movement is learned with the fingers of one hand; this change is detectable at 1 week and maximal at 4 weeks.



- When a limb is amputated its area of representation in the brain become not useless, but expansion of the neighboring area representing other body parts to this area occur.

-When a small focal ischemic lesion is produced in the hand area of the motor cortex of monkeys, the hand area may reappear, with return of motor function, in an adjacent undamaged part of the cortex.

✓ Thus, the maps of the motor cortex are not immutable, and they change with experience.

### **SUGGESTED TEXTBOOKS:**

1. Ganong's review of medical physiology 25<sup>th</sup> edition
2. Gyuton and Hall 13<sup>th</sup> edition